

IEA/SolarPACES Task I Meeting: Solar Thermal Electric Power Systems

16 April 1996

Plataforma Solar de Almeria, Almeria, Spain

Meeting Summary

An IEA/SolarPACES Task I Meeting on Solar Thermal Electric Power Systems was held in conjunction with a Task III meeting at the Plataforma Solar de Almeria on 16 April 1996. Participants from all IEA/SolarPACES countries attended. In addition to reviewing of most of the ongoing joint activities in Task I, a major new activity to assess hybrid systems was initiated, and a significant new opportunity for U. S. and European industry to jointly test and evaluate Stirling engine systems at each others facilities to help open options for marketing in the Mediterranean, Australia/Asia, and elsewhere was identified and planned. Two major systems studies were nearly complete (Tennant Creek and KSPS), and plans for review prior to the October symposium were made. An updated meeting agenda, attendees list, and presentation summaries are attached.

Detailed Meeting Minutes

The Task I meeting was chaired by Craig Tyner, as Operating Agent for Task I. After agreement on minor changes to the proposed Task I agenda (attached, as corrected), including starting with a detailed discussion of hybrid issues continuing from the Task III meeting on 8 April 96, reports of ongoing Task I activities were presented.

Potential New Activity: Hybrid Systems Studies

Following the discussions from the previous day's Task III meeting, the Task I meeting began with discussions of hybrid systems.

DLR Hybrid Activities, Rainer Koehne, DLR. Koehne discussed activities ongoing at DLR Stuttgart, including solar air preheating, the DLR/NREC Brayton, a comparison of 5 hybrid concepts including two reforming systems producing electricity, air receiver/tower systems, and a trough/combined-cycle system. The PHOEBUS project looked best at fuel savings in a solar-only mode, while from a cost perspective, PHOEBUS is most expensive and DSG is the cheapest solar addition to a combined-cycle plant. All (except PHOEBUS) were about 0.2DM/kWh for 2100h/a, while all went down to 0.12DM/kWh at high capacities with fossil fuels. The highest solar share was from solar preheating of air (although a pressurized air receiver is needed). DLR has proposed additional development of windowed receivers by up-scaling to the MW range, increasing pressure to 20 bar, and life testing. Industry, however, favors the reforming concept because of lack of interference with the fossil plant (in spite of the development required). DLR favors the air preheating and proposed it be combined first with a gas turbine plant

(Cheng cycle, not a combined-cycle), which can give 20% solar capacity and 0.19DM/kWh. Geyer pointed out that it is difficult to determine the amount/cost of the solar portion of the plant, and the discussion concluded that it is indeed difficult and important to develop the methodology for consistent comparison (see below).

IVTAN/ZSW Comparative Assessment, Oleg Popel, IVTAN. Popel then discussed an IVTAN/ZSW(Rheinlander) comparative assessment of solar plants combined with a regenerative Brayton cycle, a Brayton cycle with steam injection, and a combined cycle (all requiring 1100°C gas receivers). They had efficiencies of 43, 47, and 50%, and solar fractions of 29, 21, and 21%. Key problems include gas/gas heat regeneration and water losses. Costs ranged from 7 to 5 ¢/kWh (see again need for consistent analysis). Popel noted that there should be more cooperation with DLR and others to assure common analyses.

Task III Hybrid Activities, Klaus Hennecke, DLR. Hennecke then introduced the concept of a joint activity within IEA/SolarPACES to address hybrid systems. He discussed the history of work since Davos, and the difficulties of comparisons between the many options of hybrid systems. He proposed an activity that includes data collection from systems under consideration and then production of an information brochure to catalog options. The brochure would include an introduction, followed by a more detailed collection of concept descriptions, including concept, intended application, summary information on case study, concept assessment, and point of contact for further investigations.

Hybrid Plant Financing, Michael Geyer, DLR/PSA. Geyer then summarized issues that must be addressed to acquire financing for future hybrid plants. Basically, we must calculate cost, fuel use, and power out of a fossil-only plant, and then repeat with solar to understand the solar contribution and cost. He included a detailed spreadsheet proposed for cataloging all requirements of an analysis. Possible participants for a hybrid study include Hennecke, Geyer, Kolb, Price, Popel, Meike, Ajona, Buck. Task III work will wrap up with preparation of an initial qualitative brochure, and then all work will move to Task I for continuing quantitative analyses. The Köln meeting will be the target for the next round of input. **This is a very significant new activity within Task I; it will support new analyses within participating countries to address the issue of hybridization**

Sector 2. Distributed Generation Systems

Australian Activities, Wolfgang Meike, PAWA. Starting discussion of ongoing activities, Wolfgang Meike discussed the scale-up study of the big dish and the Tennant Creek project, and the plan for a review of the studies by IEA/SolarPACES. Grasse brought up the issue of Hanson's report and why it has not been published. A review team will be led by Meike and will probably include Mancini, Meinecke, Blezinger, and others. Before starting, however, we need agreement on what will be published, and what confidentiality agreements will be needed. No travel will be required by the review, as all

activity will be handled by e-mail and fax. A report will be available by Köln, with perhaps a presentation in Köln by Stein.

KSPS Status, V. Shadrin, Astrophysica. Shadrin then presented the KSPS status. A Phase II report is due in April with cost estimates, etc., and will be sent to DLR. Financing for this year is \$200k. Proposed PV modules are to be manufactured in June of this year, with the PV/trough system to be built by October of next year. This portion of the activity has been funded through INTAS to help Russian colleagues. A feasibility study is required to get EU funding for the actual project. Potential reviewers include Australia (Meike) and Spain (Ajona); PV concentrator experience (Mancini will try to get SunLab help); Geyer (ST vs. PV comparisons); Mancini (lead), and possibly David Faiman at Sde Boquer. The upcoming report will go to Grasse and then to Mancini. Results of the review are expected at the next task meeting. Shadrin and Popel will be the points of contact within Russia.

PSA Dish Activities, Heinrich Blezinger, DLR/PSA. Blezinger then talked regarding Distal and SBP. Installation of the three new SBP/V161 systems at the PSA will be a major activity at the PSA. Costs will, however, likely be high, although no new figures were given. In a related discussion, Tyner presented the status of the US JVP programs, and **an effort was started by Geyer, Meike, Tyner, and Blezinger to initiate a project to test an STM engine on one of the original SBP dishes at the PSA.**

Sector 1. Central Generation Systems

Geyer then chaired Sector 1 presentations.

Steam System Study, Wolfgang Meinecke, DLR. Meinecke described limited progress on the steam system study, as only limited information is available on the Australian dish (540°C, 150 bar steam), DSG (STEM), and SOLGAS (350°C or so), and the study will proceed only as data becomes available. Michael Geyer suggested a brochure on the steam boiler comparisons (similar to the hybrid activity). Fricker proposed the evaluation be of the solar “steam supply system” - S-SSS. Although this will not be a major effort, Geyer will find a student for the screening study on solar boilers. Both studies will continue until the Köln symposium, at which time an evaluation of how to proceed will be made.

SOLGAS and THESEUS. Both have applied to EU (DGXVII - energy) for funding. THESEUS is being developed by Pilkington Solar . The proposed plant will be in Crete, connected to the local grid. The solar resource is 2300kWh/m²/yr (measured), even though it is almost on the beach; the climate is very similar to Almeria. Crete is now peaking with old gas turbines (fuel cost alone 25¢/kWh); part of the base load is diesel, with an overall average cost of all power of 10¢/kWh. The grid has a current availability to consumers of only 92% (compared to 99.96% typical). The plant will be 52MW solar; 30 to 50% solar depending on amount of diesel firing, and is projected to cost \$155M (of which \$100M is solar). This amounts to about \$300/m² (\$250/m² solar); levelized energy

costs would be 13¢/kWh (cheaper than peaking, but more than base). Pilkington is ready to share information in Task I. Abengoa, Solel, Pilkington, and a turbine manufacturer are potential participants.

On SOLGAS, the final report for the feasibility study is complete. Now, the cogeneration option has been dropped, and a refit of a 65MW Rankine plant with a 32,000m² power tower solar plant producing saturated steam (21MW) combined with a 30MW gas turbine. The plant has been proposed to the THERMIE program for EU funding. It is a good opportunity for early gas turbines to enter into the Spanish market by getting a permit for a new combined-cycle with solar. Higher efficiency will also give an economic advantage in the Spanish situation. Major participation of Spanish industry (all of the solar field) will likely be required. A decision by the EU is expected by late summer. Task I may need to remove SOLGAS from its list of cooperative activities because of proprietary issues; it will probably be moved to the information sharing category.

University of Sydney System, Wolfgang Meike, PAWA. Meike gave a brief discussion of plans for a University of Sydney (David Mills) system of low-concentration-ratio collectors for electric power production (with natural gas superheating) for use at the 2000 Olympics. Total size would be about 35MW, looking at a future of 70MW in the Northern Territories. Michael Geyer then asked about a US company called PowerRoof trying to build roof mounted systems, which have some similarities.

START Team Activities, Michael Geyer, DLR/PSA. Geyer then discussed the START team efforts in Egypt, including financing methods, types of activities and information, and expected outcomes. Activities included site data review and recommendations; recognition of resource supporting up to 900GW; helping draft a terms of reference document to help in support of GEF or other financing; and potential feasibility study configurations including 2 ISCCS options and an ISGPS (integrated solar and gas power system). Egypt will be asking for \$1M from the GEF for the feasibility study. Apparently, because of the evening peak demands, Egypt is also interested in power towers with storage to meet requirement for matching load curves. The team was very well received by Egypt. The next START mission may be in Brazil, but no date is yet set. Jordan and/or South Africa may also be soon, perhaps next fall.

Task I Highlights: Input for the 1995 Annual Summary

Finally, a list of highlights for the annual report and for presentation at the next ExCo meeting, as prepared by Tyner, were accepted as most representative of the Task's activities.

- DLR/NREC/Sandia cooperative effort to fabricate a dish volumetric receiver/Brayton engine system for test on a Sandia concentrator.
- Cooperative evaluations of Tennant Creek, Australian Dish Scale-Up, Kislovadskaya Solar Power Station, and SOLGAS studies.

- Initiation of cooperative Steam System and Hybrid System Studies.
- Initiation of operations of Solar Two, field testing of prototype units of SBP, SAIC, Cummins dish/Stirling systems, and initiation of DISS activities.

Action Items Summary (all designated 9604-#)

1. Meike - Coordinate and initiate the Tennant Creek/Scale-Up Study Review; complete and report by Köln meeting.
2. Mancini - Coordinate and initiate the KSPS project review; complete and report by Köln Meeting.
3. Hennecke - Initiate and document a brochure on all proposed hybrid systems designs; prepare a plan (with Geyer) for moving all activities to Task I by Köln meeting.
4. Geyer - Initiate a steam boiler study (with student) and, with Meinecke, prepare proposal on how to proceed within Task I by Köln meeting.
5. Geyer - Determine the status of SOLGAS and THESEUS participation in Task I.

IEA/SolarPACES Task I: Electric Power Systems

Task I Meeting

Plataforma Solar de Almeria
Almeria, Spain
16 April 1996

Agenda (Post-Meeting Update)

Introduction and Objectives	Tyner
Hybrid Systems Analysis Approaches- Potential New Activity	Hennecke et al
World Bank Support	Tyner
Update on Significant Progress	
Sector 2: Distributed Generation Systems	Tyner
Sector 1: Central Generation Systems	Geyer
Developing non-Technical Support Activities	postponed
Approaches to Addressing Environmental Issues	postponed
Summary of Task 1 Highlights for 1995	Tyner

IEA/SolarPACES

Task I: Electric Power Systems

Task Meeting Summaries:

Plataforma Solar de Almeria, Almeria, Spain 16 April 96

DLR-Stuttgart, Stuttgart, Germany 9 October 95

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November 19, 2001

IEA/SolarPACES Task I Participants:

Since the last task meeting summaries published in March, 1995, we have had two IEA/SolarPACES Task I: Electric Power Systems task meetings: one at DLR in Stuttgart on 9 October 95, and one at the PSA in Almeria, Spain, on 16 April 96. Please find enclosed my summaries of these meetings. The table below provides a snapshot of Task I at this time, including all activities either currently underway or under consideration as new (with new and potential new activities in bold type). Note that in addition to the two existing sectors, a number of cross-cutting issues have been identified. Cooperative activities are those involving more than one country as active participants, while information-sharing activities are those where the participants have agreed to provide regular informational updates to the Task.

Task I: Electric Power Systems (C. E. Tyner, Operating Agent)

Sector 1. Central Generation Systems (M. Geyer, Sector Leader)

Cooperative Activities:

- O&M Cost Reduction (KJC; expanded to include O&M consulting for new activities)
- Direct Steam Generation System Comparison (Meinecke, DLR)

Information-Sharing Activities:

- Solar Two (Sandia, U. S. utility)
- Phoebus/TSA (Phoebus consortium)
- DISS (Sanchez, CIEMAT; cooperative participation under consideration)
- Dead Sea Works/MDAC Systems (Epstein, WIS)
- SOLGAS Review (SODEAN)

Sector 2. Distributed Generation Systems (T. R. Mancini, Sector Leader)

Cooperative Activities:

- Dish/Brayton Demonstration (Sandia, NREC, DLR)
- Dish/Engine Compendium (Cal Poly, Sandia, all others with input)
- Comparative dish/Stirling testing and evaluation at PSA and Obninsk (Grasse, DLR)
- Tennant Creek Review (Stein, Pacific Power)
- Kislovodskaya Solar Power Station Review (Mancini, Sandia (d/S); Grasse, DLR (PV))
- STM4-120/V-161 Cooperative Engine Testing and Evaluation (Mancini, Sandia; Geyer, DLR/PSA)**

Information-Sharing Activities:

- Dish/Stirling Joint Venture Program (Cummins, Sandia)
- Utility-Scale Joint Venture Program (Cummins, SAIC, Sandia)
- SBP Systems Testing and Development (Schiel, SBP)

Cross-Cutting Activities (potentially a new Sector)

Hybrid Systems Studies (Hennecke, DLR; Geyer, DLR/PSA)

START Team Missions (Geyer, DLR/PSA)

World Bank Support (Tyner, Sandia)

Approaches to Addressing Environmental Issues

Developing Non-Technical Support Activities (potentially a new Task)

I will continue to work with the Sector Leaders and Activity Coordinators to facilitate formalization of the potential new activities, including presenting a status report to the Executive Committee in October in Koln. Thanks for your active participation in Task I activities and for helping expand our areas of cooperation.

Sincerely,

Craig E. Tyner
Operating Agent, Task I

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16 April 96

(in conjunction with Task III and 8th Symposium Scientific Committee meetings)

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DLR-Stuttgart, Stuttgart, Germany

9 October 95

(in conjunction with Task III meeting and the VDI Solar Thermal Conference)

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IEA/SolarPACES Task I Distribution

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[Include full distribution list here.

The Access Database needs to be updated to include all the individuals on the following page (the Task I Fax list), with a separate listing for each name. Get current addresses; enter into database (update existing if available), checking master list category and a new category (“IEA/SP Task I”); enter phone and fax where available. See me for any missing addresses and to proof list. Thanks. CET]